Geographical Disparities of Lung Cancer Mortality Centered on Central Appalachia

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ABSTRACT

This article explores regional disparities in lung cancer mortality for females and males and associated factors across central Appalachia and surrounding regions. It asks, how are lung cancer mortality rates distributed geographically, what are the relative contributions of specific factors to lung cancer disparities by sex, and how do the effects of these factors vary across the study area? This study is based on county-level data of potential determinants of disease to explore local effects on lung cancer mortality. It analyzes these data using a combination of spatial statistical analyses. The analysis shows that the spatial clustering of high lung cancer mortality rates differs for females and males. Additionally, the factors associated with lung cancer for females and males differ greatly. For instance, tobacco use is associated with male lung cancer mortality, but not with female lung cancer mortality. These factors also vary in their geographical relationships with female and male lung cancer mortality.

Keywords: Appalachia, Geographical Disparities, Health Disparities, Spatial Statistics

INTRODUCTION

We explore factors influencing geographical disparities in lung cancer mortality for females and males across central Appalachia and the surrounding area. Previous research reveals elevated mortality rates for a variety of causes clustered in Appalachian Kentucky and adjacent portions of West Virginia, Virginia, and Tennessee. In addition, high rates of lung cancer and related respiratory diseases in central Appalachia have been generally assumed to result from tobacco use and coal mining. These factors, however, are interconnected with restricted access to health care providers and measures of socioeconomic deprivation, such as high levels of poverty and unemployment, and low levels of educational attainment. While some of these factors have been investigated previously, their geographical distributions have received less...
attention. Hence, our primary research questions are, how are lung cancer mortality rates distributed across central Appalachia, what are the relative contributions of specific factors that influence lung cancer disparities by sex, and how do the effects of these factors vary across the study area?

Our analysis reveals a complex pattern of clustered high rates of lung cancer mortality across the study area with the largest cluster centered in eastern Appalachian Kentucky. Surprisingly, the rate of tobacco use and employment in mining activities are not significant factors influencing the clusters of elevated lung cancer mortality rates in these areas. The size of the effects of particular factors also varies across the study area. For instance, physical inactivity is a primary factor in central Kentucky, but less so in rural western and eastern Kentucky. Similarly, the geographical clustering of high lung cancer mortality rates and the associated factors differ for females and males across the study area. Specifically, tobacco use is a significant factor for male, but not for female lung cancer mortality.

To facilitate geographical analysis, this study is based on county-level data of lung cancer mortality rates and a wide variety of measures of potential determinants of lung cancer mortality. We analyze these data using a combination of traditional and spatial statistical techniques. Descriptive statistics and spatial descriptive statistics provide the initial evaluation of variables and a way to assess the degree of spatial autocorrelation of specific factors. OLS regression and spatial regression provide the means to test the global model linking lung cancer mortality and potential determinants. Geographically weighted regression calculates regression coefficients for all locations in the study area and reveals geographical variation in the relationships connecting the independent variables with lung cancer mortality.

The geographical disparities evident in health outcomes in Appalachia and in the other variables used in the study necessitate the use of spatial analytical techniques. Conclusions drawn from standard statistical analysis of spatial data are often flawed, because the independence of observations and the homogeneity of variance cannot be reliably assumed. Until recently, however, few techniques existed to simultaneously assess complex spatial patterns. These analytical techniques have revolutionized the way researchers explore numerous subjects (Hochberg, Earle, & Miller 2000), including poverty (Hall, Malcom, & Piwowar, 2001), education (Clarke and Langley, 1996), economics (Gamper-Rabindran, 1996), health (Gatrell, 2002; Gatrell & Senior, 1999; Meade & Earickson, 2000; Ricketts, 2003), the environment (de Savigny & Wijeyartne, 1995; Lyon & McCarthy, 1995), and policy (Birkin, Clarke, & Clarke, 1999; Rushton, 2001). GIS allows analysts to explore relationships that are difficult to study using traditional techniques. In public health, spatial analytical techniques encourage research on the “quantitative analysis of health-related phenomena in a spatial setting” (Gatrell & Senior, 1999, pg. 925) through disease mapping, risk assessment, and disease clustering (Cromley, 2003; Elliot et al., 2000). These techniques enhance health geography research through spatial regression (Fotheringham et al., 2002), boundary analysis, and space-time analysis (Jacquez et al., 2000). These techniques hold promise for better understanding the factors influencing disease disparities and geographical variation.

Epidemiological studies identify a complex set of interacting factors that influence health status generally and lung cancer incidence and mortality specifically. Smoking is the leading contributor to lung cancer morbidity rates, causing incidence rates to increase nine times in smokers over nonsmokers (Raaschou-Nielsen, Ole et al., 2011). Smoking also has lasting effects with studies showing that even former smokers have over twice the risk of lung cancer as lifelong nonsmokers (Alavanja, et al., 2011). Similarly, asbestos exposure has odds ratios ranging from 1.88 to 2.0 (Alavanja, et al., 2011; Cassidy, et al., 2008).

Less directly, an individual’s socioeconomic status can affect health outcomes through many pathways, such as limited access to af-
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